Monitoring report form for CDM project activity
(Version 07.0)

Complete this form in accordance with the instructions attached at the end of this form.

MONITORING REPORT		
Title of the project activity	La Vuelta and La Herradura Hydroelectric Project	
UNFCCC reference number of the project activity	0735	
Version number of the PDD applicable to this monitoring report	15	
Version number of this monitoring report	02.0	
Completion date of this monitoring report	12/07/2019	
Monitoring period number	10th monitoring period	
Duration of this monitoring period	01/01/2018 – 31/12/2018	
Monitoring report number for this monitoring period	Not applicable	
Project participants	Empresas Públicas de Medellín E.S.P. (private) MGM Carbon Portfolio, S.a.r.l	
Host Party	Colombia	
Applied methodologies and standardized baselines	ACM0002 (version 15)	
Sectoral scopes	1: Energy Industries (renewable/ non-renewable sources)	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0 tCO_2e	73,285 tCO_2e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	77,149 tCO_2e	

SECTION A. Description of project activity

A.1. General description of project activity

La Vuelta and La Herradura Hydroelectric Project (hereinafter "the project") is a hydro power plant with a total installed nameplate capacity of 33.48 MW, in order to take advantage of the capacity of La Herradura River, by means of two subprojects in a chain (La Vuelta and La Herradura). The proposed subprojects were not strictly built to cover the expected increase in electricity demand but to add efficiency to the local electricity system as a whole, improving electricity service in the West of Antioquia Department, and contributing to the regional sustainable development, while reducing CO_2 emissions.

The project displaces other generation sources connected to the local grid that use fossil fuel to produce energy. The project provides clean energy and reduces CO_2 emissions in Colombia (host country).

The following table shows a description of the technology that was included in the registered PDD as well:

Table 1: Design data of La Vuelta and Herradura Hydroelectric Project

Hydro Plant / Characteristic	La Vuelta	La Herradura
Nominal capacity	12.4 MW	21.08 MW
Mean flow	12 m^3/s	10 m^3/s
Net design fall	112.9 m	230.6 m
Hydraulic turbine	Francis horizontal axis. One unit only.	Francis horizontal axis. Two units.

The construction of the facilities started in April 2002. La Herradura was completed and fully commissioned in October 2004, followed by La Vuelta in December/2014, at which points they started commercial operations. The power plants have been generating electricity since then.

The emission reductions achieved by the implementation of the project activity for the monitoring period from 01/January/2018 to 31/December/2018, are 73,285 tCO_2e.

A.2. Location of project activity

The project activity is located in the Republic of Colombia. The two power plants are sited in the North-western region of Antioquia Department, under the jurisdiction of Cañasgordas, Frontino and Abriaquí municipalities, although the Urabá Antioqueño can be considered as regional area of influence, which goes from Santa Fe de Antioquia to Arboletes.

La Herradura Sub-Project

La Herradura hydro power plant is located on La Herradura River, starting from an existing topographic fall between mentioned river and the Cañasgordas River. Both rivers later join to form the Sucio River basin, which contributes to a mean flow of 14 m^3/s at catchment point. The construction is located in Frontino and Cañasgordas municipalities jurisdictions.

The geographical coordinates of La Herradura power plant are -76.09º; 6.73º (-76°05'18.01"; 6°43'49.60").

La Vuelta Sub-Project

La Vuelta hydro power plant is located in the upper and middle basin of La Herradura River, up to the fork at the Nancuí Gulch, at 1,595 m elevation, covering all the municipality of Abriaquí. The limits coincide with the dividing basin and, to a lesser extent, with Frontino municipality. The hydrographic basin area of La Herradura River contributes to a mean flow of 12.3 m^3/s at catchment point.

The geographical coordinates of La Vuelta hydro power plant are -76.08º; 6.80º (-76°04'52.90''; 6°48'10.08'').

Both plants are connected to Chorodó substation at 44kV[1]. Location -76.14°; 6.85° (-76°08'16.50''; 6°50'53.93'').

Figure 1: Location of Project Activity

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Colombia (host)	Empresas Públicas de Medellín E.S.P. (EPM)	
Switzerland	MGM Carbon Portfolio, S.a.r.l. (private)	

A.4. References to applied methodologies and standardized baselines

The methodology applied to the registered CDM project activity is ACM0002 Version 15: "Consolidated methodology for grid-connected electricity generation from renewable sources". The

[1] http://www.industcards.com/hydro-colombia.htm

methodology also refers to the "Tool for demonstration and assessment of additionality". By the time of project activity registration, the available tool version was Version 02.

The grid emission factor is calculated according to the "Tool to calculate the emission factor for an electricity system" (version 4.0.0).

The tool "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" (version 03.0.1) is also applied.

The "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" is not used either as there are no project or leakage emissions related to the project activity.

A.5. Crediting period type and duration

The second crediting period of the project activity goes from 01/01/2012 to 31/12/2018 (renewable).

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

The project is fully implemented and operational since the end of 2004. No events or situations occurred during the monitoring period, which may impact the applicability of the methodology.

During the monitoring period maintenance was performed according to the schedule established for this purpose, as can be verified by the DOE in the project log books.

Table 2: Project Activity Implementation Events

Hydro Power Plant / Events	La Vuelta	La Herradura
Construction Start Date	15/April/2002	22/April/2002
Operation Start Date	18/December/2004	08/October/2004

Technologies and/or measures

The project activity consists of two hydroelectric power plants, with a total installed turbine capacity of 33.48 MW[2] , in order to take advantage of the capacity of La Herradura River, by means of two subprojects in a chain (La Vuelta and La Herradura).

La Vuelta Sub-Project – Technical Details

Table 3: La Vuelta hydro power plant – technical details

Hydraulic Turbine	
Type	Francis, horizontal axis

[2] As per post registration changes PRC ref No. PRC-0735-001, approved on May 20-2014.

Number of units	1
Nameplate capacity (without losses)	12,400 kW[3]
Rotation speed	870 min-1
Design net head	112.9 m
Generator	
Type	Synchronic, horizontal axis
Number of units	1
Nominal power output (nameplate)	14,000 kVA
Nominal tension	13,800 V
Nominal frequency	60 Hz
Power factor (cosine ø)	0.85
Synchronic speed	514.3 rpm

La Herradura Sub-Project – Technical Details

Table 4: La Herradura hydro power plant – technical details

Hydraulic Turbine	
Type	Francis, horizontal axis
Number of units	1
Nameplate capacity (without losses)	10,540 kW[3]
Rotation speed	900 min-1
Design net head	230.6 m
Generator	
Type	Synchronic, horizontal axis
Number of units	2
Nominal power output (nameplate)	12,000 kVA
Nominal tension	13,800 V
Nominal frequency	60 Hz
Power factor (cosine ø)	0.85
Synchronic speed	900 rpm

Turbine Regulator: programmable digital type with electronic head operated from central or by remote control from another control centre. It also has an electro-hydraulic system for normal operations of synchronization, charge and discharge.

Transformers: It has been decided the use of an outdoors transformer for the two generators, with a capacity of 24 MVA: three-phase, with primary nominal voltage of 13.8 kV and secondary of 44 kV and 60 Hz, oil-cooled under normal conditions and by forced air under operating conditions at continual maximum capacity.

Mechanical auxiliary equipments: Oil in bolsters is cooled in a dry type tower, the oil circuit is closed and the pumps are directly propelled by the unit axis. For the drainage of the spiral

[3] As per post registration changes PRC ref No. PRC-0735-001, approved on May 20-2014.

chamber, the relief valve discharge pit, the draft duct and infiltrated water and power house floors drainage, there is a system with submergible vertical pumps installed in the drainage pit to conduct water to the discharge channel.

Electric auxiliary equipments: A 480 kV-13.8 kV transformer is used as normal feed, fed from any of the two generators as main source. It has a diesel electric generator of 480 V and 60 Hz emergency system[4].

Each generation unit has a control centre and a 480 V distribution board so that maintenance and selection processes in auxiliary services operations are independent. There is a surveillance system and water level control in the load tank. Therefore, the central is interconnected, so as to secure accurate load tank operation hydraulic conditions.

Turbine specifications: The turbines are Francis reaction turbines, with a martensitic stainless steel welded impeller, with spiral chamber and welded draft pipe from soothed carbon steel sheets, of thin austenitic grain size.

A Francis turbine is a type of hydraulic reactor turbine where the flow exits the turbine blades in radial direction. Francis turbine is common in power generation facilities and is used in applications where high flow rates are available at medium hydraulic head (e.g. Niagara Falls). Water enters the turbine through a casing and is directed to the blades by wicket gates. The low momentum water then exits the turbine through a draft tube.

Francis turbines can be assembled both vertically and horizontally. Figure bellow shows a Francis turbine where water can enter freely through the whole circumference and through the outer ring of the guide vanes. These guide vanes can be adjusted so the amount of incoming water may be controlled. Francis turbines are highly efficient and versatile turbines (inflow-impulse type in the first stage and outflow-axial reaction type in the second stage).

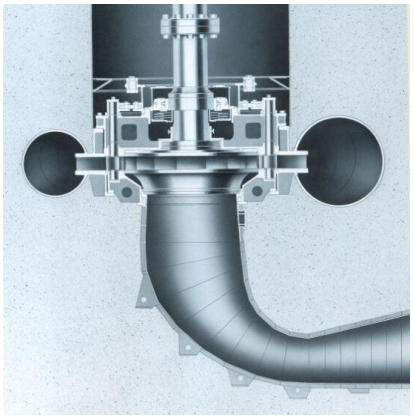

Figure 2: Francis Turbine Spiral Cased Horizontal Shaft – typical arrangement

[4] As stated in the methodology ACM0002 version 15.0.0, “the use of fossil fuels for the back up or emergency purposes (e.g. diesel generators) can be neglected”; thus, potential emissions from the emergency diesel generator at the project site are neglected.

Project operation during this monitoring period

Two hydroelectric power plants real availability

Table 5: Hydroelectric power plants real availability during the monitoring period

Month	La Vuelta	La Herradura
January	97.8%	98.1%
February	99.1%	97.1%
March	95.0%	98.5%
April	21.1%	95.8%
May	60.0%	89.5%
June	92.3%	96.5%
July	98.0%	98.9%
August	98.3%	82.9%
September	92.7%	85.5%
October	94.2%	85.2%
November	76.5%	78.5%
December	57.2%	88.4%
Average	**81.9%**	**91.2%**

Most significant maintenance procedures

There were some maintenance procedures during 2018 that implied the suspension of the electricity generation in a period longer than 24 hours. It influenced the real availability and the electricity generation.

For the management of energy generation machine shutdowns, EPM manages a registry where the events that occur in the plants are recorded, as well as the most relevant observations respect to the situation that is occurring. Machine shutdowns come from two situations:

a) The cause of the availability interruption is originated from the process itself, at the moment in which a failure occurs or a maintenance is made. In this case, the impact is captured with values that determine how much energy is left to generate. For example, when the fault "Stop due to high temperature in the axial bearing" occurs, or when there is a maintenance "Output of the machine to attend semi-annual preventive maintenance".

b) The cause of machine stops is generated by situations outside or outside the process, which means that the machine's functionality is in optimal conditions, but due to external effects (for example, torrential avenues, storms, among others) energy can not be generated and therefore, although the machines remain in an available state, there would be no value for impact. EPM states that this situation does not generate an impact for the process and therefore the value in the column "Impact (MWh) is zero.

Identifying the cause of machine shutdowns makes it possible to determine the impact.

Table 6: Suspension of the electricity generation longer than 24 hours

	Power plant	Duration	Time (h)	Impact (MWh)
to an emergency fault or operation	La Vuelta	07/04/2018 08:49 to 26/04/2018 17:00	464.18	5,477.36
	La Vuelta	01/05/2018 00:00 to 11/05/2018 22:30	262.50	3,097.50
	La Herradura	07/03/2018 18:25 to 16/03/2018 11:08	208.72	0.00
	La Herradura	19/08/2018 06:59 to 26/08/2018 09:47	170.80	1,690.92
	La Herradura	01/03/2018 14:49 to 07/03/2018 07:30	136.68	0.00

	Power plant	Duration	Time (h)	Impact (MWh)
	La Herradura	22/07/2018 19:16 to 28/07/2018 05:29	130.22	0.00
	La Herradura	26/11/2018 16:10 to 01/12/2018 00:00	103.83	0.00
	La Vuelta	26/04/2018 17:00 to 01/05/2018 00:00	103.00	1,215.40
	La Herradura	17/03/2018 11:59 to 21/03/2018 03:25	87.43	0.00
	La Vuelta	27/12/2018 14:19 to 31/12/2018 00:22	82.05	968.19
	La Herradura	01/09/2018 00:00 to 03/09/2018 22:11	70.18	91.24
	La Herradura	17/09/2018 20:06 to 20/09/2018 16:18	68.20	675.18
	La Vuelta	23/12/2018 16:16 to 26/12/2018 12:08	67.87	800.83
	La Herradura	01/06/2018 00:00 to 03/06/2018 18:29	66.48	0.00
	La Herradura	23/05/2018 07:00 to 25/05/2018 20:10	61.17	605.55
	La Herradura	01/12/2018 00:00 to 03/12/2018 08:31	56.52	0.00
	La Herradura	11/10/2018 00:30 to 13/10/2018 07:40	55.17	0.00
	La Herradura	26/08/2018 10:24 to 28/08/2018 15:36	53.20	0.00
	La Vuelta	21/12/2018 11:24 to 23/12/2018 13:12	49.80	587.64
	La Herradura	22/05/2018 17:00 to 24/05/2018 17:44	48.73	482.46
	La Herradura	27/11/2018 21:08 to 29/11/2018 17:41	44.55	0.00
	La Herradura	11/08/2018 12:03 to 13/08/2018 02:30	38.45	0.00
	La Herradura	28/07/2018 16:49 to 30/07/2018 05:49	37.00	0.00
	La Herradura	29/08/2018 12:03 to 30/08/2018 21:35	33.53	0.00
	La Vuelta	19/12/2018 07:03 to 20/12/2018 14:03	31.00	365.80
	La Vuelta	17/12/2018 14:22 to 18/12/2018 21:03	30.68	362.06
	La Vuelta	20/11/2018 07:30 to 21/11/2018 12:52	29.37	346.53
	La Herradura	21/02/2018 08:26 to 22/02/2018 12:05	27.65	273.73
	La Herradura	09/08/2018 12:44 to 10/08/2018 14:15	25.52	0.00
	La Herradura	21/11/2018 17:56 to 22/11/2018 18:38	24.70	244.53
	La Vuelta	26/12/2018 12:20 to 27/12/2018 12:55	24.58	290.08
	Total		**2,693.77**	**17,575.01**

B.2. Post-registration changes

B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies, standardized baselines or other methodological regulatory documents

There were no temporary deviations from registered monitoring plan or applied methodology during the current monitoring period.

B.2.2. Corrections

A post registration change (PRC ref. No. PRC-0735-001) was submitted and accepted by the Chair of the CDM Executive Board on 20/May/2014.

B.2.3. Changes to the start date of the crediting period

There were no changes to the start date of the crediting period during the current monitoring period.

B.2.4. Inclusion of monitoring plan

There were no post registration changes to include a monitoring plan into the PDD.

B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other methodological regulatory documents

This is not applicable.

B.2.6. Changes to project design

There are no changes to project design of registered project activity.

B.2.7. Changes specific to afforestation or reforestation project activity

This is not applicable.

SECTION C. Description of monitoring system

The Monitoring Plan is based on i) recording electricity generation of La Vuelta and La Herradura hydro power plants and ii) obtaining the data required to calculate the grid emission factor: electricity generation and fuel consumption of all power plants serving the interconnected national system.

Considering the project boundary and that the combined margin CO_2 emission factor is determined *ex-ante*, the electricity generation is the only parameter to be monitored in order to calculate emissions reduction.

Electricity Generation

The hydro power plants La Vuelta and La Herradura belong to the *Dirección Pequeñas Centrales Generación Energía* under the *Vicepresidencia Generación Energía*, in charge of the operation and maintenance of both hydro power plants. Monitoring procedures can be implemented on site or remote, using tele-measurement technology. The *Equipo de Medida* (Measurements Team) of "Empresas Públicas de Medellín" (EPM) is in charge of taking the measurements. The Measurements Team is responsible for reporting to *XM Compañía de Expertos en Mercados S.A. E.S.P.* (XM), the operator of the National Dispatch Center, on the Generation Boundaries, the boundaries between the agents and the large energy clients supplied by EPM. In the case of La Vuelta and La Herradura, the energy meters (in Chorodó substation) are read via the MV-90i software every 24 hours and uploaded in the GCE-*Grandes Clientes de Energía* software.

Once the information is uploaded, a file is created (cr41/mes/día.TXT) and sent to XM. The codes assigned by XM to this project are:

- EVLT1001 LA VUELTA
- EHRD1001 LA HERRADURA

Electricity generation is measured by electronic electricity meters. The values are cross-checked with the generation measured in terminals and vs. SCADA (Supervisory Control And Data Acquisition) system.

Electronic Electricity Meters

Table 7: Characteristic of electronic electricity meters

La Vuelta Electricity Meters	
Main	**Backup**

Serial: 36099685	Serial: 36099687
Type: SL761A061	Type: SL761A061
Brand: ACTARIS	Brand: ACTARIS
Voltage: 3x57.7/100 V – 3x240/415 V	Voltage: 3x57.7/100 V – 3x240/415 V
Current: 5(10) A	Current: 5(10) A
Calibration constant: 10000 Wh/Imp	Calibration constant: 10000 Wh/Imp
TP measure: 44000/V3/120/V3V	TP measure: 44000/V3/120/V3
3 Phases – 4 lines	3 Phases – 4 Lines
TC Measure: 300/5	TC measure: 300/5
Class: 0.2 S	Class: 0.2 S
La Herradura Electricity Meters	
Main	**Backup**
Serial: 36099681	Serial: 36099684
Type: SL761A061	Type: SL761A061
Brand: ACTARIS	Brand: ACTARIS
Voltage: 3x57.7/100 V – 3x240/415 V	Voltage: 3x57.7/100 V – 3x240/415 V
Current: 5(10) A	Current: 5(10) A
Calibration constant: 10000 Wh/Imp	Calibration constant: 10000 Wh/Imp
TP measure: 44000/V3/120/V3V	TP measure: 44000/V3/120/V3
3 Phases – 4 lines	3 Phases – 4 Lines
TC Measure: 300/5	TC measure: 300/5
Class: 0.2 S	Class: 0.2 S

The information is backed up by the IT Department of EPM through the software for GCE-Grandes Clientes de Energía (Large Energy Consumers). Daily data are read remotely using MV-90xi software. The IT Department does information backups of the GCE database on a daily basis at 8PM through the SQL Server. The backup of the previous day is overwritten by the backup of the following day. During the day, backups of the transaction log from the same database are made every three hours. The files are copied to a tape every day during a week. In this way, there is always an available backup of the previous week. Additionally, a tape is kept per week during a month and a tape per month, for three months.

Figure 3 shows the power plants, the substation and the metering points:

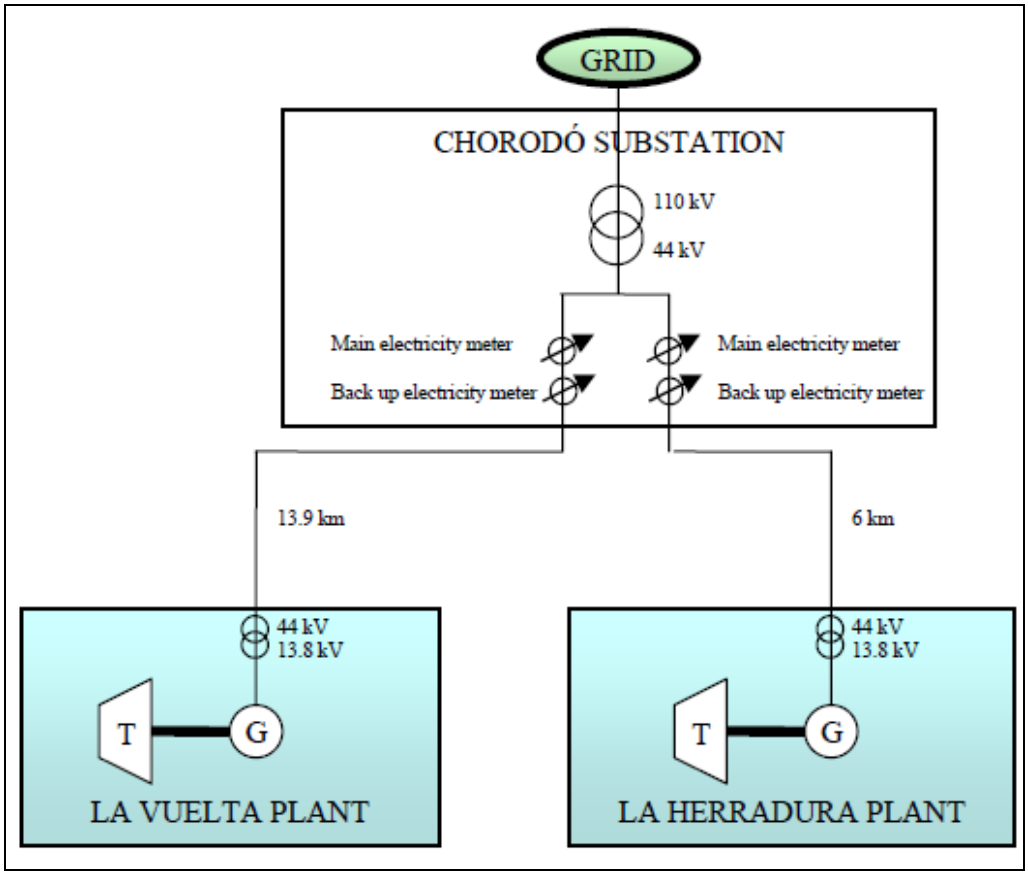

Figure 3: Project Activity Electricity Generation Scheme

Figure 4 shows a single-line diagram of Chorodó substation.

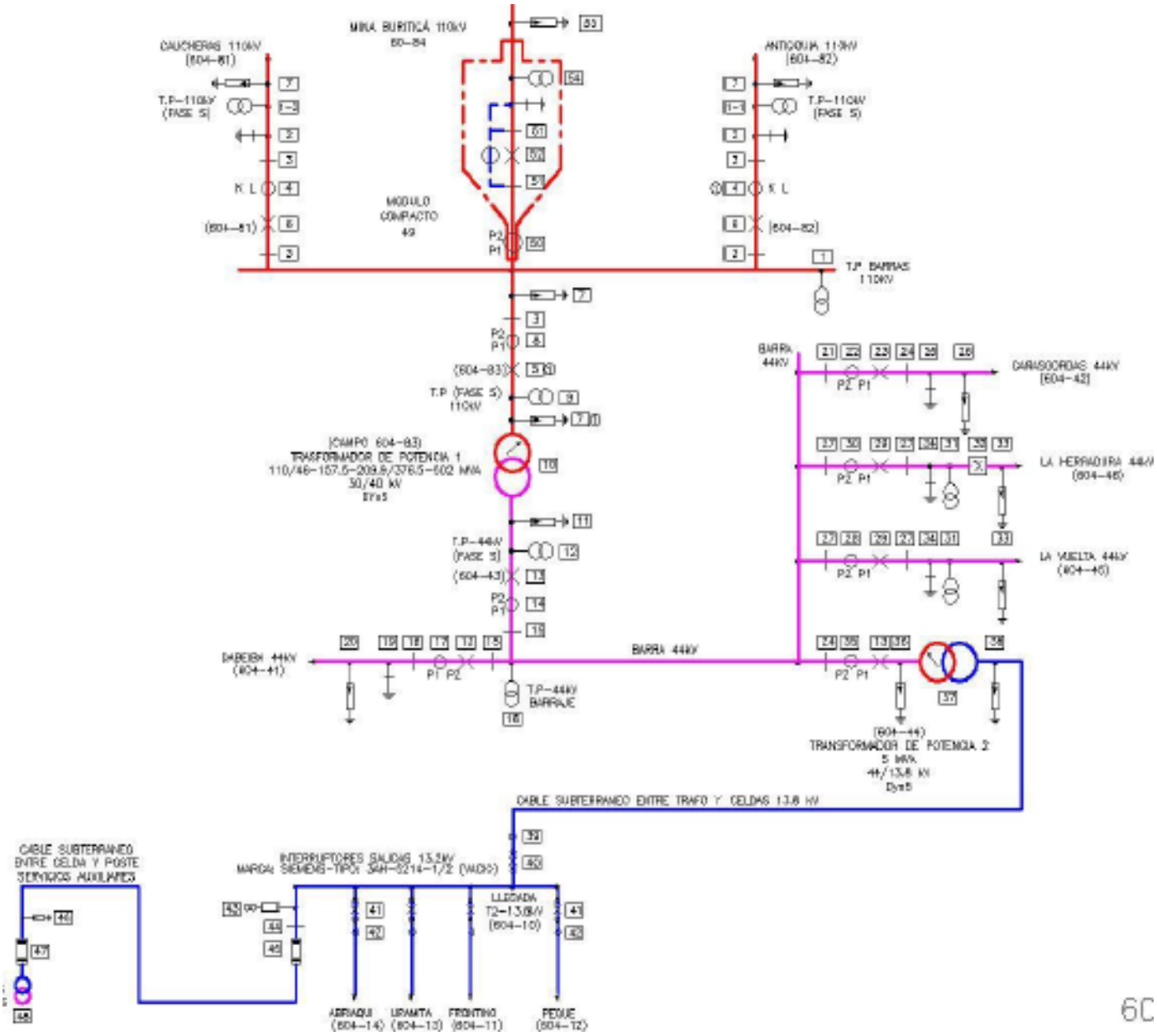

Figure 4: Single-line diagram of Chorodó substation

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Environmental Management Plan

It is important to note that this environmental management plan was not included as part of the monitoring plan in the PDD. This is an independent initiative taken by EPM that contributes to sustainable development of the region.

La Vuelta and La Herradura hydro power plants apply an environmental management plan that includes actions towards mitigating the negative impacts on environment during construction and operation of the plants. In addition, EPM developed a discretionary environmental management plan that involves physical-biotic and social aspects to protect natural resources and to promote a sustainable development of the hydroelectric complex. The plan consists of:

Management of Environmental Impacts:

- The Environmental Licenses consider concessions and permits of spills and river banks occupation and adaptation of the internal ways of the hydroelectric plants. To achieve this, the information requirements of the *Corporación Autónoma Regional Corpourabá* (Autonomous Regional Corporation of Corpourabá) need to be met regarding environmental monitoring programs. Report on turbinated flows once every three months to the *Corporación Autónoma Regional Corpourabá* (Autonomous Regional Corporation of Corpourabá).
- Monitoring and control of the flow designated for energy generation and for water consumption.
- Inspection and maintenance of domestic wastewater treatment systems belonging to the hydroelectric system facilities.
- Monitoring of domestic wastewater treatment systems in order to verify the efficiency and the compliance with the estimated removal percentages in accordance with the environmental law.
- Implementation of a solid wastes management system including different containers corresponding to different type of solid wastes. Moreover, tows and sheets soaked with oils are delivered to a third party for treatment and final disposal in accordance with the applicable law.
- Visits from officials of the *Corporación Autónoma Regional Corpourabá* (Autonomous Regional Corporation of Corpourabá) to follow up on the application of the plan and to identify opportunities for improvement.

Additional discretional programs of environmental management

Process of Environmental Impacts Management:

- Hydrologic monitoring: rainfall, runoff, transport of sediments and water quality of the main source.
- Water quality monitoring of the sources that supply drinking water to the facilities of the hydroelectric complex.

Process of Conserving Natural Resources:

- Geomorphological study of La Herradura River and its river dynamics in order to implement measures to control the critical factors that generate the torrential conditions and the high production of sediments in the basin.

In 2007, the recovery of several points of erosion of the La Herradura River basin was initiated. In this regard, 22,500 m2 of affected areas due to erosion were identified as part of the program to implement activities tending to protect the surface, control of runoff and stabilization of the areas in order to control the supply of sediments that affect the machines that generate energy.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

Data/Parameter	$EF_{grid,CM,y}$
Unit	tCO_2/MWh
Description	Combined margin CO_2 emission factor for grid connected power generation in year *y* calculated using the latest version of the "Tool to calculate the emission factor for an electricity system" (version 4.0.0).

Source of data	Calculated in accordance with the "Tool to calculate the emission factor for an electricity system" (version 4.0.0) based on fuel consumption of the individual power plants connected to the grid. All data used for the analysis is from *XM Compañía de Expertos en Mercados S.A. E.S.P.,* which is the market administrator, and being in charge of the National Dispatch Center.
Value(s) applied	0.4239 tCO_2/MWh
Choice of data or measurement methods and procedures	Derived from registered PDD (version number 15, dated 16/06/2014) which was calculated based on the methodology tool.
Purpose of data/parameter	Baseline emissions calculations.
Additional comments	For both the operating margin and the build margin, the *ex-ante* option is applied as given in the "Tool to calculate the emission factor for an electricity system" (version 4.0.0).

D.2. Data and parameters monitored

Data/Parameter	EG_y
Unit	MWh/year
Description	Electricity generation by the plant. Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y*.
Measured/calculated/ default	Measured. Net generation is continuously measured, hourly registered and monthly recorded with the following electricity meters located at the substation Chorodó. The meters are bi-directional and therefore measure the net balance of the quantity of electricity supplied by the project plant to the grid and the quantity of electricity delivered to the project plant from the grid (as given in the methodology).
Source of data	Empresas Públicas de Medellín (EPM).
Value(s) of monitored parameter	172,883.72 MWh See table in Section E.1. for details.

<table>
<tr><td>Monitoring equipment</td><td>
<table>
<tr><th colspan="2">Plant</th><th>Serial N°</th><th>Type</th><th>Class</th><th>Cal. Freq.</th><th>Calibration Date</th></tr>
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02/05/2012
29/05/2013
10/04/2014
29/04/2015
04/12/2017
01/11/2018</td></tr>
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02/05/2012
29/05/2013
10/04/2014
29/04/2015
04/12/2017
31/10/2018</td></tr>
<tr><td rowspan="2">La Herradura</td><td>Main</td><td>36099681</td><td>SL761A061</td><td>0.2S</td><td>2 y</td><td>29/03/2011
02/05/2012
29/05/2013
10/04/2014
29/04/2015
05/12/2017
31/10/2018</td></tr>
<tr><td>Back Up</td><td>36099684</td><td>SL761A061</td><td>0.2S</td><td>2 y</td><td>29/03/2011
02/05/2012
29/05/2013
10/04/2014
29/04/2015
05/12/2017
30/10/2018</td></tr>
</table>
</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Hourly measurements and monthly recording.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Not applicable.</td></tr>
<tr><td>QA/QC procedures</td><td><u>Calibration of meters:</u>
Calibration tasks follow national standards and are in accordance with the calibration instructive specified in Colombian standard NTC 4856 for electricity metering devices. The calibration frequency is maximum every 2 years, as defined by EPM, since there is no regulatory requirement for calibration frequency.
EPM has adopted its own procedure based on the Colombian technical norm NTC-ISO-IEC 17025 and NTC 4856, under the so-called “Instructive to perform on-site electricity meter proofs with a pattern metering device” (DIS-EM-LE-IN-009-01). This procedure is carried out to verify that the meters are working properly with the corresponding accuracy. They are also checked by a system of alarm reminder.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Baseline calculation.</td></tr>
<tr><td>Additional comments</td><td>All data collected as part of the monitoring process is archived electronically and kept at least for two years after the end of the last crediting period.</td></tr>
</table>

D.3. Implementation of sampling plan

There is no sampling involved in the monitoring of the proposed project activity.

SECTION E. Calculation of emission reductions or net anthropogenic removals

E.1. Calculation of baseline emissions or baseline net removals

According to the applied methodology, baseline emissions are calculated as follow:

$$BEy\,(tCO_2/yr) = EGy\,(MWh/yr) \times EFy\,(tCO_2/MWh) \qquad \text{Equation (1)}$$

Where:

BEy: Baseline emissions in year *y* (t CO_2/yr)

EGy: Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM Project activity in year *y* (MWh/yr)

EFy: Combined margin CO_2 emission factor for grid connected power generation in year *y* calculated using the latest version of the "Tool to calculate the emission factor for an electricity system" (t CO_2/MWh)

In the project activity *EGy* is the project net electricity generation (comprising La Vuelta and La Herradura hydro power plants) and *EFy*, is the grid emission factor calculated as the weighted average of the Operating Margin emission factor (EF_{OM_y}) and the Build Margin emission factor (EF_{BM_y}).

Electricity Generation (*EGy*)

Table 8: Net Electricity Generation during the Monitoring Period

Year	Month	Net Electricity Generation (MWh)		
		La Vuelta	La Herradura	TOTAL
2018	January	7,550.26	13,176.19	20,726.46
	February	4,719.40	9,593.27	14,312.67
	March	4,445.03	8,605.87	13,050.90
	April	1,183.87	10,655.59	11,839.46
	May	3,904.47	7,532.50	11,436.97
	June	6,889.71	10,163.93	17,053.64
	July	5,749.46	9,538.84	15,288.29
	August	4,523.83	7,617.63	12,141.46
	September	5,924.11	9,344.09	15,268.20
	October	6,339.95	9,143.45	15,483.40
	November	4,644.81	7,807.42	12,452.23
	December	4,168.64	9,661.40	13,830.04
	TOTAL	**60,043.54**	**112,840.18**	**172,883.72**

The monthly electricity generation data are presented in the "2018 LV LH monitoring ER v1.xls". It can also be found in the web of XM through NEON system: http://informacioninteligente10.xm.com.co/pages/default.aspx

Emission Factor (EF*y*)

As per the registered PDD for the second crediting period, the grid emission factor is determined once at the validation stage, thus no monitoring or recalculation of the emissions factor during the crediting period is required.

Emission factor calculation:

- *Operating Margin (OM):* 0.5546 tCO_2/MWh
- *Build Margin (BM):* 0.3804 tCO_2/MWh
- *Combined Margin (CM):* EF_y, is the grid emission factor (combined margin emission factor) calculated as the weighted average of the Operating Margin emission factor (EF_{OMy}) and the Build Margin emission factor (EF_{BMy}), as follows:

$$EFy = w_{OM} \times EF_{OM,y} + w_{BM} \times EF_{BM,y} \quad \text{Equation (2)}$$

The relative weights according to the default value provided by the methodology are 0.25 for w_{OM} and 0.75 for w_{BM}.

EF_y = 0.25 x 0.5546 tCO_2/MWh + 0.75 x 0.3804 tCO_2/MWh = **0.4239 tCO_2e/MWh**

Emissions reduction calculation:

$ERy = EGy \times EFy$

ERy = 172,883 MWh x 0.4239 tCO_2e/MWh = **73,285 tCO_2e** (according to EGy, year 2018)

Please note that the value applied for EG_{2018} was rounded down.

E.2. Calculation of project emissions or actual net removals

No project emissions are considered in the present project activity.

E.3. Calculation of leakage emissions

No leakage emissions are considered in the present project activity.

E.4. Calculation of emission reductions or net anthropogenic removals

	Baseline GHG emissions or baseline net GHG removals (t CO_2e)	Project GHG emissions or actual net GHG removals (t CO_2e)	Leakage GHG emissions (t CO_2e)	GHG emission reductions or net anthropogenic GHG removals (t CO_2e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	73,285	0	0	0	73,285	73,285

E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period (t CO_2e)	Amount estimated ex ante for this monitoring period in the PDD (t CO_2e)
73,285	77,149

E.5.1. Explanation of calculation of "amount estimated ex ante for this monitoring period in the PDD"

The amount of emissions estimated ex ante for this monitoring period (in the actual PDD) was calculated as follow:

$$ER_{2018\ (tCO2/yr)} = EG_{2018}\,(MWh/yr) \times EF_{2018}\,(tCO_2/MWh) \qquad \text{Equation (1)}$$

Where:

ER_{2018}: Amount of emissions estimated ex ante for year 2018 (t CO_2/yr)

EG_{2018}: Quantity of net electricity generation estimated ex ante and supplied as a result of the implementation of the CDM Project activity in year 2018 (MWh/yr)

EF_{2018}: Combined margin CO_2 emission factor for grid connected power generation in year *y* calculated using the latest version of the "Tool to calculate the emission factor for an electricity system" (t CO_2/MWh)

In the project activity EG_{2018} is the project net electricity generation supplied by the project plants (comprising La Vuelta and La Herradura hydro power plants) in year 2018. The value applied (according to section B.7.1 in PDD version 15) for EG_{2018} is **182,000 MWh** (rounded down average of the historical data from 2008 to 2010, which correspond to the last three years of the first crediting period).

EF_{2018} is the grid emission factor calculated as the weighted average of the Operating Margin emission factor ($EF_{OM\ 2018}$) and the Build Margin emission factor ($EF_{BM\ 2018}$). See the explanation about how it was obtained in section E.1 "Emission Factor (EF_y)". The value applied (according to section B.6.2 in PDD version 15) for EF_{2018} is **0.4239 t CO_2/MWh**.

So:
$$BE_{\ 2018\ (tCO2/yr)} = 182{,}000\ (MWh/yr) \times 0.4239\ (tCO_2/MWh)$$
$$BE_{\ 2018\ (tCO2/yr)} = 77{,}149\ tCO_2/yr$$

E.6. Remarks on increase in achieved emission reductions

The actual emission reductions during the monitoring period are lower than the ones anticipated ex-ante in the CDM-PDD hence there is no need of explanation of any increase.

E.7. Remarks on scale of small-scale project activity

This is not applicable.

Document information

Version	*Date*	*Description*
07.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Add a section on remarks on the observance of the scale limit of small-scale project activity during the crediting period; • Add "changes specific to afforestation or reforestation project activity" as a possible post-registration changes; • Clarify the reporting of net anthropogenic GHG removals for A/R project activities between two commitment periods; • Make editorial improvements.

Version	*Date*	*Description*
06.0	7 June 2017	Revision to: • Ensure consistency with version 01.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Make editorial improvements.
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from *F-CDM-MR* to *CDM-MR-FORM*; • Editorial improvement.
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB 70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.

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